Angle of Position and Distance of α^1 *Centauri* with regard to α^2 *Centauri*, from Melbourne Transit Observations.

Year.	Dist.	P.	No. of Measures.
1862·47	...	0	3
	′	°	
1865·56	9·95	17·3	1
1868·51	11·02	21·8	5
1870·65	10·45	24·7	3
1871·51	9·41	24·2	1
1872·55	10·36	24·1	1
1875·94	6·68	39·3	1
1876·90	4·94	64·3	1

Melbourne Observatory,
1877, *April* 17.

On the Collective Light and Distribution of the Fixed Stars. By John J. Plummer, M.A.

The object of the following paper is to determine within fair limits of approximation the total illuminating power of the stars as compared with some acknowledged photometric standard. In endeavouring to do this I have been led to certain considerations regarding the distribution of the stars in space which are not in accordance with the theory so ably enunciated by Mr. Stone in the March No. of the *Monthly Notices*, but point to a more complicated structure of the sidereal universe. Although readily obtainable from existing data, these remarks may not be the less interesting to the fellows of the Society, as I am not aware that they are to be found elsewhere.

The numbers of the stars of each magnitude are now known with great accuracy for the northern hemisphere, from the careful analysis by Littrow of Argelander's *Survey of the Northern Heavens*. Nothing more satisfactory could be desired as regards the enumeration of the stars. The photometric value of Argelander's scale of magnitudes has been investigated by Pogson. The light-ratio determined by this observer is 2·512, but it will be sufficiently approximate to assume the first decimal place only as accurate. Further, it does not seem possible to fix any inferior limit to the magnitude of the stars which contribute towards illuminating sensibly our Earth, because it is well known that those which individually are too faint to affect the retina of the eye, when congregated in sufficient numbers, become distinctly visible as hazy light; and it would appear that every star, however small or isolated, must aid in the general illumination of the heavens in proportion to its apparent lustre.

The following table has been obtained by combining the two sources of information already mentioned, and gives the number of sixth magnitude stars to which the total light of the stars of the several classes into which Littrow has divided the *Durchmusterung* are equal:—

Class.	Limiting Magnitudes.	No. of Stars in Northern Hemisphere by Littrow and Argelander.	No. of Stars of 6th mag. to which they are equal.
1	1·0 to 1·9	10	646·6
2	2·0 „ 2·9	37	957·0
3	3·0 „ 3·9	130	1344·9
4	4·0 „ 4·9	312	1291·1
5	5·0 „ 5·9	1001	1656·9
6	6·0 „ 6·9	4386	2904·0
7	7·0 „ 7·9	13823	3660·9
8	8·0 „ 8·9	58095	6154·4
9	9·0 „ 9·5	237131	12069·3

If we assume that one-half of the light in class 6 comes from stars that are visible to the naked eye, we shall have the brighter stars equal to 7349, and the telescopic stars down to the 9·5 magnitude inclusive, equal to 23337 standard stars of the sixth magnitude, or that fully $\frac{3}{4}$ of the light of a fine night is derived from stars individually invisible to the naked eye. Next, taking the light of *Sirius* equal to 324 stars of the sixth magnitude, it will be found that the total light of the whole of the stars of the *Durchmusterung* is equal to 10·17 × *Venus* at maximum brilliancy, or to $\frac{1}{78{\cdot}6}$ of the mean full moon. As these results must be approximately true for any hemisphere of the heavens, it follows that (disregarding the light of the fainter telescopic stars, of whose numbers we have no estimate) the illuminating power of all the stars above the horizon at one time is not less than $\frac{1}{80}$th part of the illumination due to the full moon; but it should be remarked that in this estimate no deduction has been made for the absorption of light in passing through the lower portions of our atmosphere.

With reference to the stars fainter than those here considered, a difficulty presents itself. If their numbers increase in the same ratio as obtains in those for which we have determined a light equivalent, it must be admitted that only a small portion of the stellar light has been here taken into account; and it becomes desirable to determine whether from some cause or other there does not exist a greater number of stars of the 9th and 10th magnitudes than the usual theory of stellar distribution in space will account for. In dealing with large numbers of stars the most probable supposition is, that variations of real lustre will be equalised, and that an average equal distribution fairly repre-

sents the actual condition of things. This amounts to the assumption that distance is the sole cause of variation of magnitude, which, while manifestly untrue for a few stars, must be accepted as approximately accurate for large numbers. If, therefore, we select one of the classes in Littrow's analysis as containing an average number of stars compared with the space included within the limits of distance which the light-ratio assigns, it is easy to determine the number of stars that each of the other classes should contain. I have calculated these numbers for each class, on the supposition that class 8 contains such an average density of the stellar stratum, whose limits are determined by the light-ratio previously used; but, from what has already been said, no great accordance is to be looked for except where a large number of stars are concerned.

Class.	True Numbers according to Littrow.	Calculated Numbers.	Radius of Sphere forming Exterior Limit of Distance (Dist. of 6th Mag. Star=1).
1	10	5	0·156
2	37	15	0·247
3	130	60	0·391
4	312	238	0·618
5	1001	941	0·977
6	4386	3718	1·545
7	13823	14697	2·443
8	58095	(58095)	3·863
9	237131	99631	5·085

An inspection of this table shows that the final class contains a much larger number of stars than can be accounted for in this manner, and further that the comparison would not have been materially altered had either of the four preceding classes been selected as of average density. The significance of this fact may perhaps be more strikingly shown thus. Within the limit 0·39 the numbers of the stars exceed the average, but are too few to admit of our saying decisively that they do not conform to the law of density that prevails at greater distances. From 0·39 to 3·86 one uniform law of stellar distribution prevails, while from 3·86 to 5·08 more than twice that density of stars must be assumed to account for their greatly increased numbers. The use of the light-ratio found by Carrington is equally ineffective to explain the facts, and there appears to me but two suppositions capable of doing so. Either the *Durchmusterung* of Argelander contains many stars (more than one-third of the entire number) which, though rated as 9·5 magnitude, are sensibly below it,* or

* This is equivalent to assuming that the light-ratio, which applies well to the whole of the earlier portions of the scale, fails completely towards the end, and it is a point which I have long had some intention of investigating. At present it is but justice to the deserved reputation of Argelander to assume that his scale of magnitudes is as uniform at the end as elsewhere.

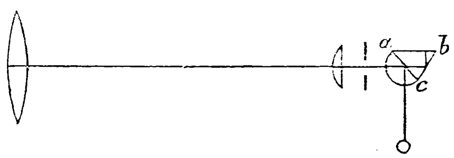
else it must be assumed that, at the average distance for stars of this magnitude, a denser stratum actually exists, succeeded possibly by regions less fruitful beyond. Having been led to the latter conclusion in opposition to preconceived ideas, I cannot but think that the enormously increased ratio with which the numbers of the telescopic stars are multiplied is deserving of increased interest and continued discussion.

Orwell Park Observatory.

A new Solar Eye-piece. By Prof. Zenger.

The Solar Eye-pieces for viewing the Sun by large telescopes were devised for the purpose of getting rid of the obnoxious glare of the solar radiation. By dark coloured glasses, absorbing fluids, reflection from polished glass surfaces, with or without the aid of polarisation of light, it was possible to view the Sun. But all these contrivances could not entirely satisfy the requirements of solar observations; either there was a much diminished field, as is the case in using Dawes's solar eye-piece, or there was a loss of definition by the use of polarising eye-pieces, or by double or triple reflection from the plane surfaces.

To obviate all these hindrances, I imagined a solar eye-piece consisting of a catadioptric lens, the last lens in the eye-piece being replaced by a hemispherical lens, with a carefully worked plane surface, inclined 45° to the optical axis of the telescope. By this replacement the field of view is scarcely affected at all, and the definition is unaltered, or even improved; for the hemispherical lens reflecting the solar rays into the eye at (O) works like a spherical lens, and the curvature may be lessened in comparison with a plano-convex lens in the ratio



$$1 : \frac{2-n}{2}, \text{ or nearly } 1 : 0{\cdot}24 = 25 : 6 = 4\frac{1}{6} : 1.$$

There is an equilateral prism placed in optical contact with the plane surface of the hemispherical lens, and denoting by n the index of refraction of the lens, and by n' that of the prism, the intensity of the reflected light by the plane surface ac will be

$$\frac{T_r^2}{T^2} = \frac{\tan^2(\alpha - \alpha')}{\tan^2(\alpha + \alpha')}.$$

The central rays falling on the lens and emerging after reflection, at the angle of 45°, by ac, will be greatly reduced in intensity if there is only a small difference in the reflecting power of the two media.